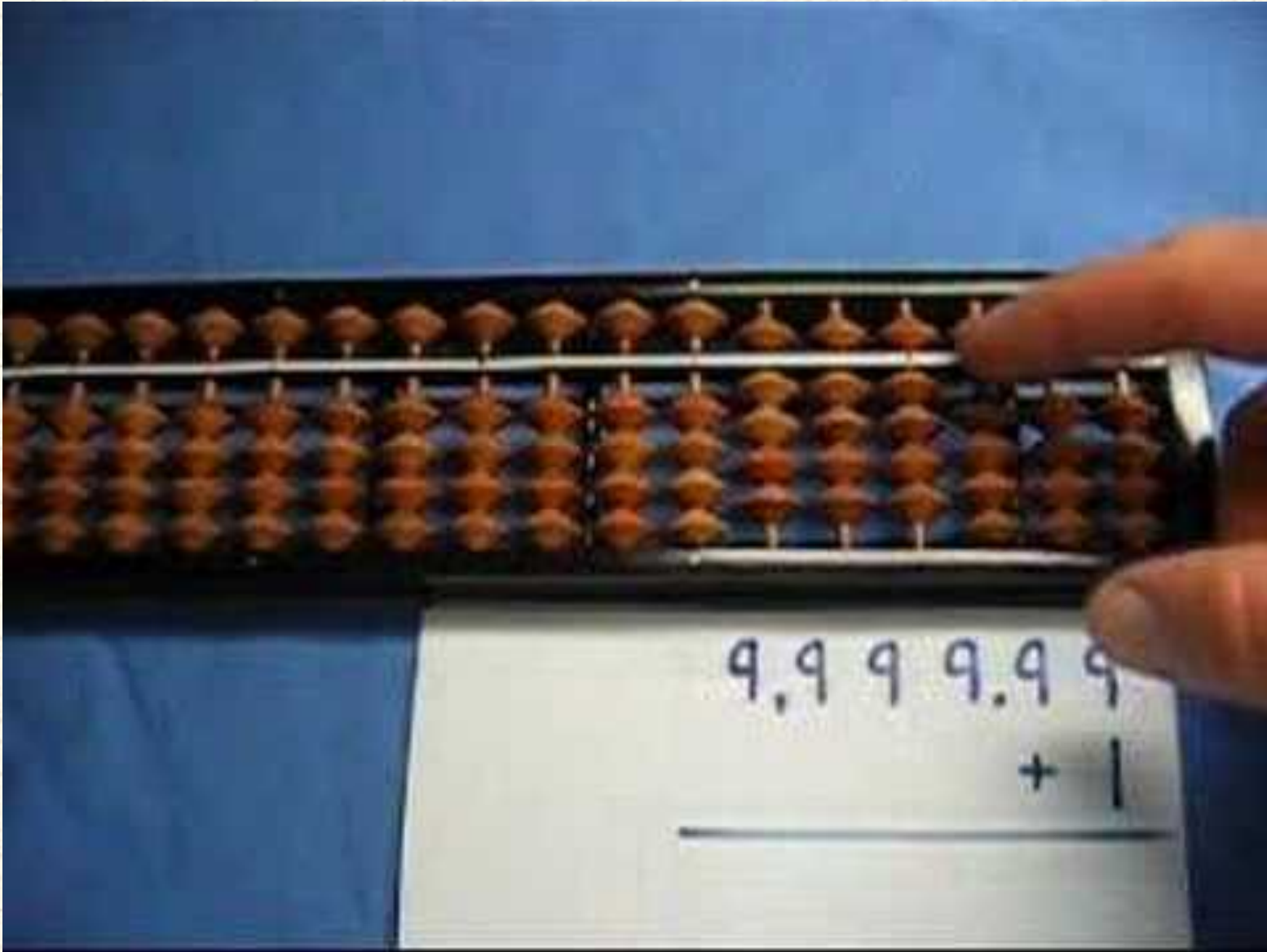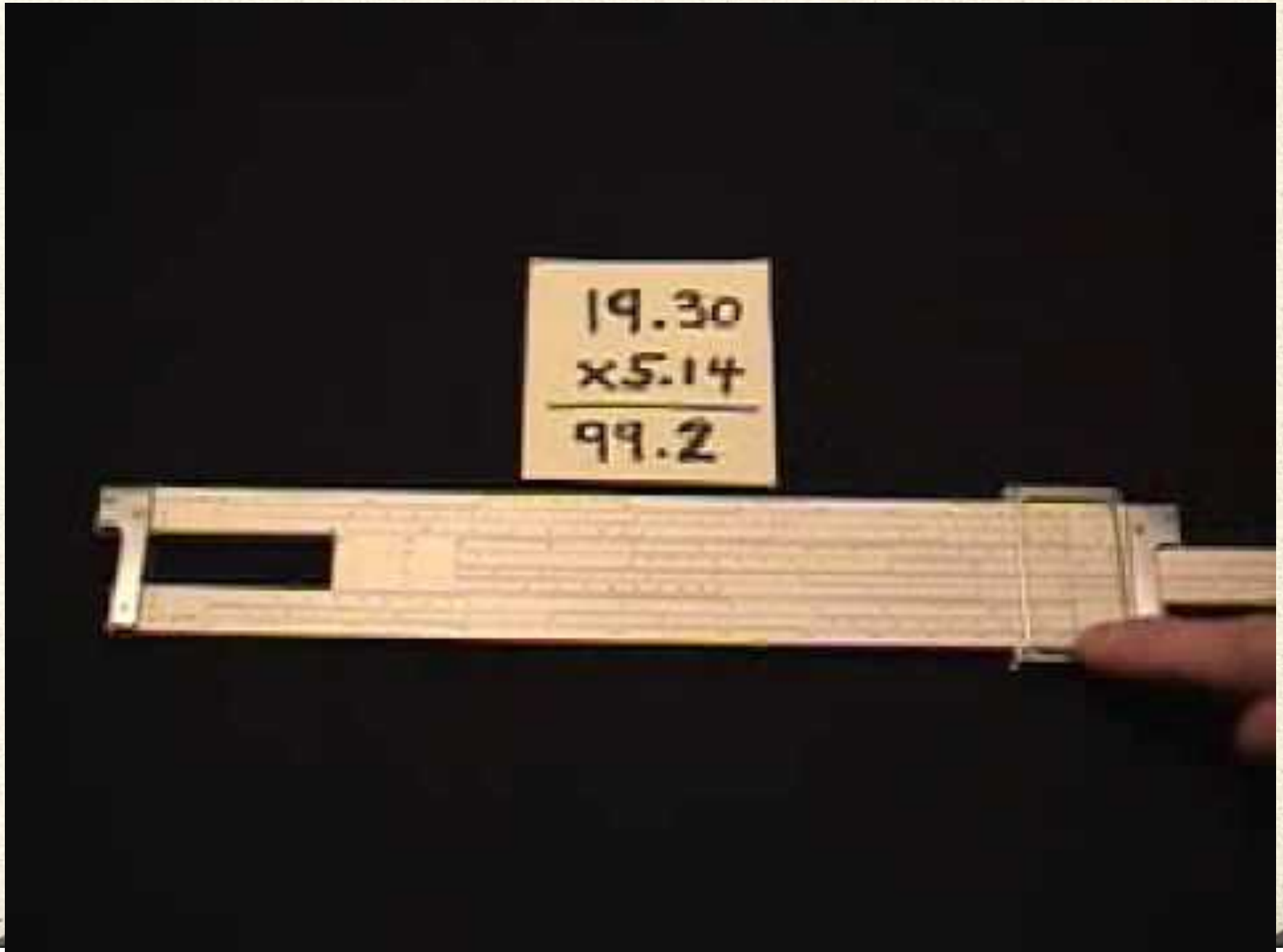# Computers

Boy Scout Troop 405
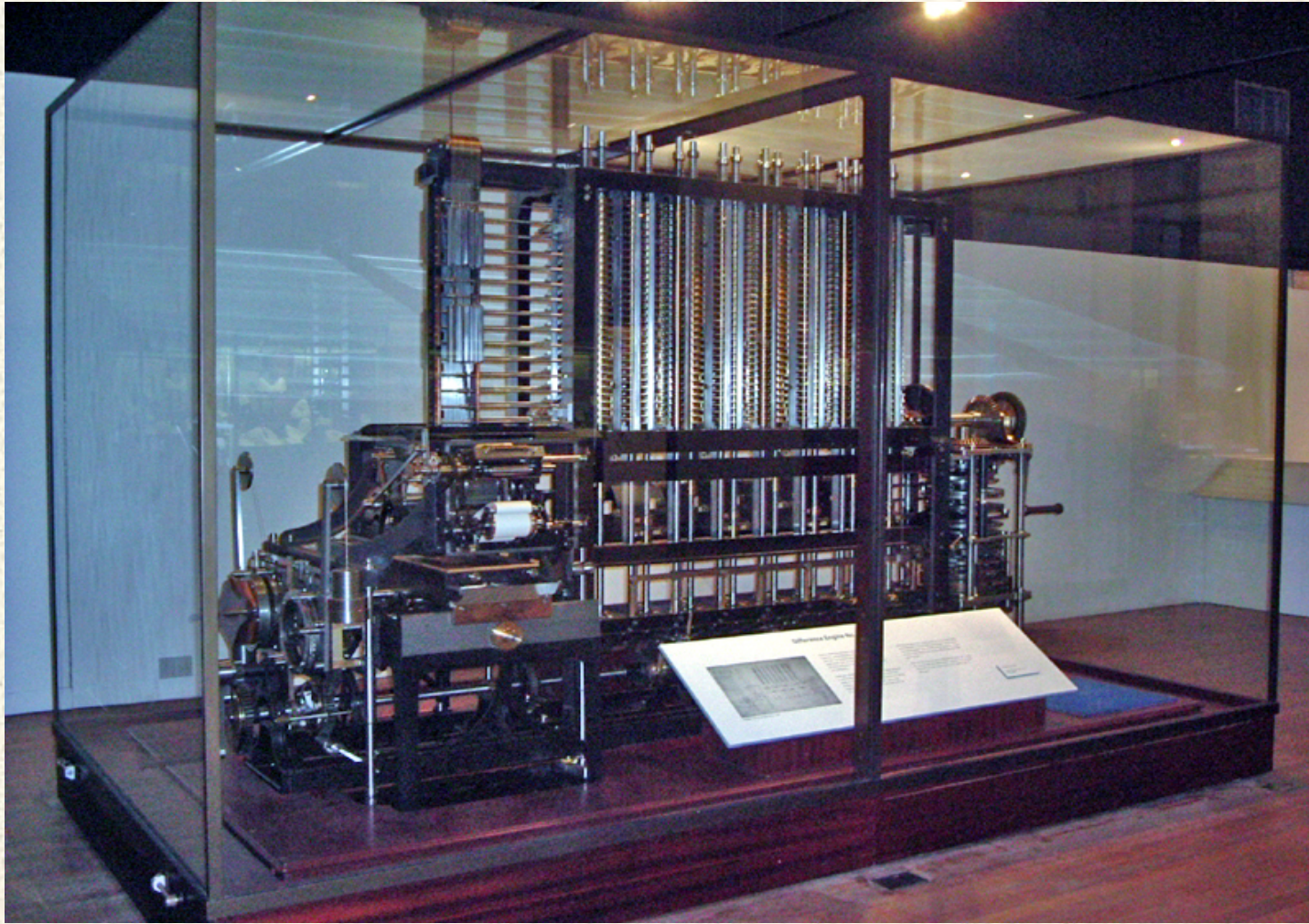
What is a computer?

Is this a computer?

Charles Babbage: Father of the Computer

1830s
Designed mechanical calculators to reduce human error.

*Input device
*Memory to store instructions and results
*A processors
*Output device

Vacuum Tube

Edison 1883 & Lee de Forest 1906 discovered that "vacuum tubes" could serve as electrical switches and amplifiers

A switch can be ON (1) or OFF (0)

Electronic computers use Boolean (George Bool 1850) logic to perform calculations

It's all complicated series of ON of OFF switches in a complicated heirarchy
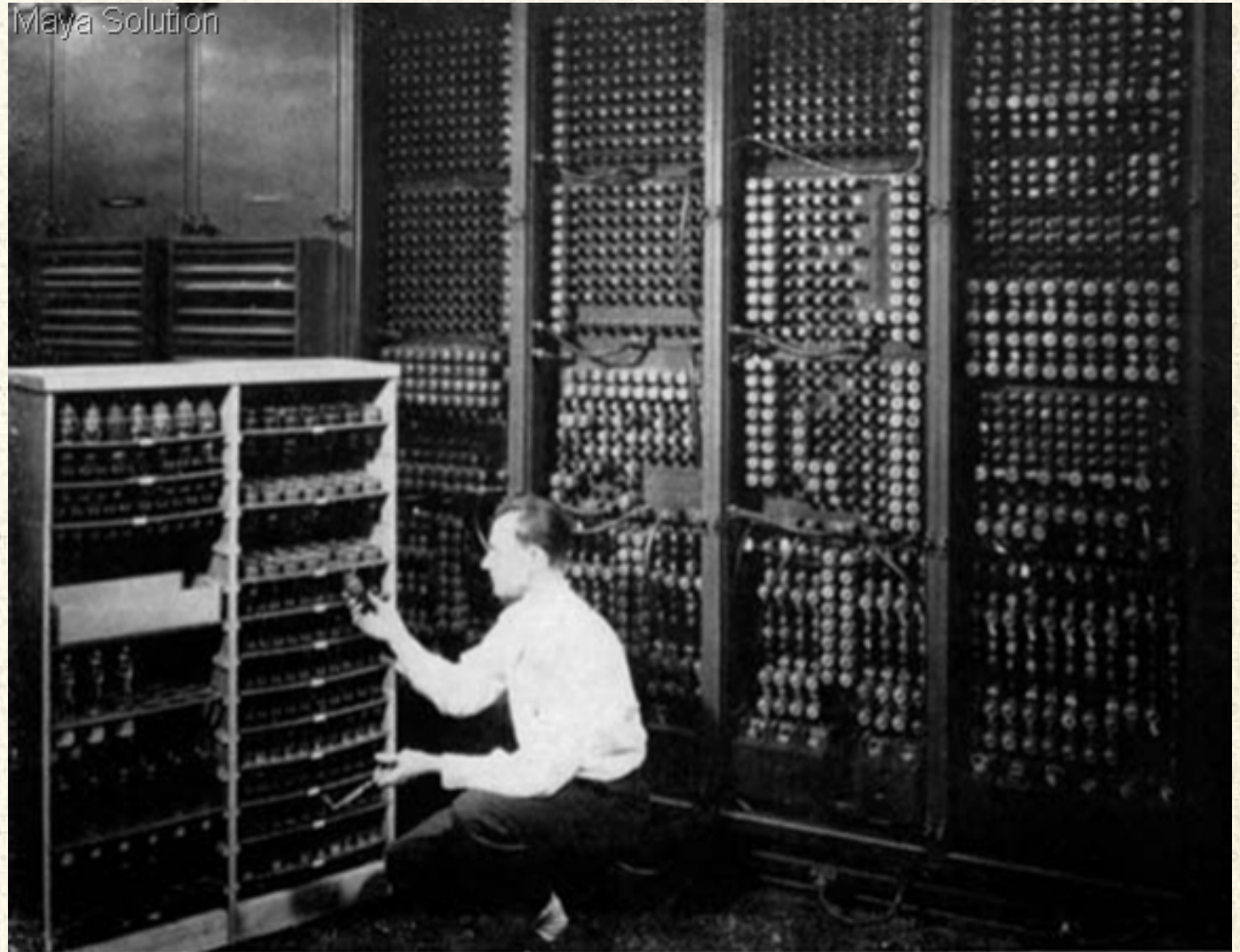
The ENIAC

1947

20 tons

100 KHz clock

$6 million

5 million
hand-soldered
joints
17,000 vacuum
tubes

Replacing a bad tube meant checking among ENIAC's 19,000 possibilities.

About 1,000 calculations per second
Military applications: trajectories, design

Grace Hopper
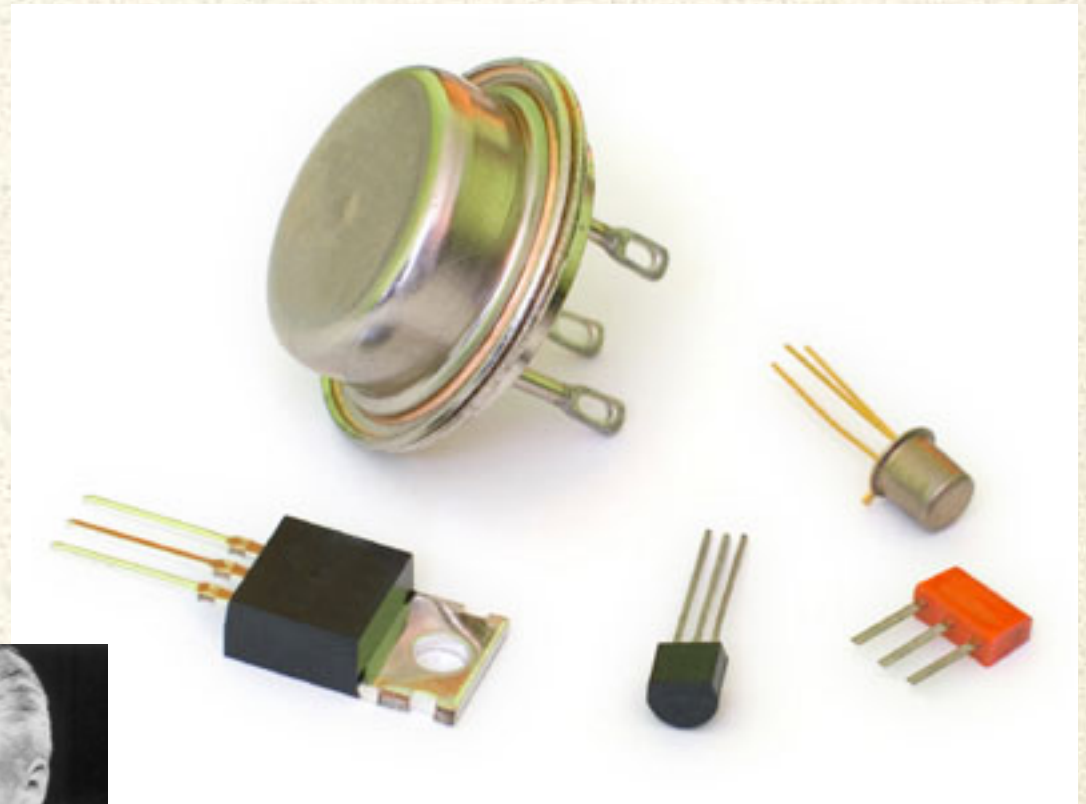

First compiler 1952
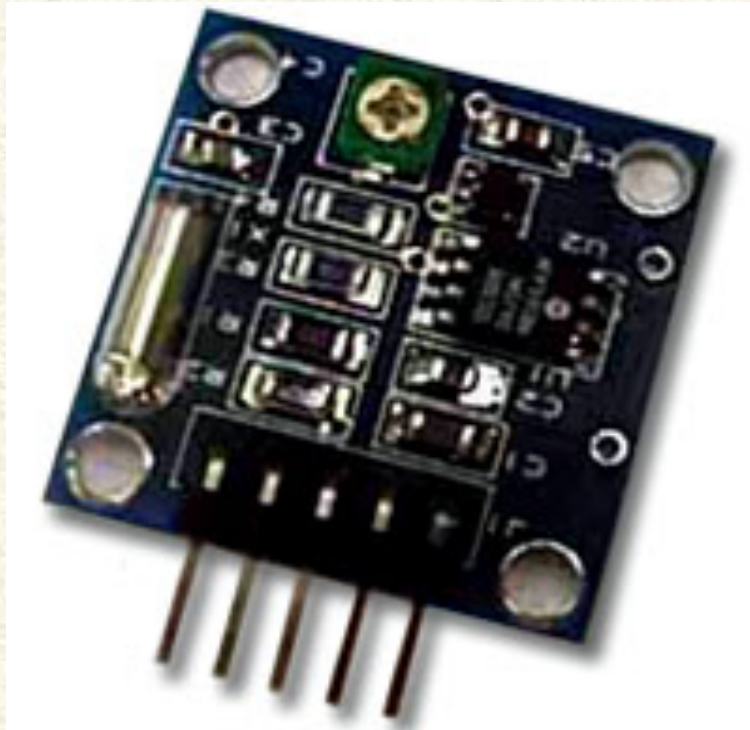Coined the term "bug"

Transistors

1947
John Bardeen,
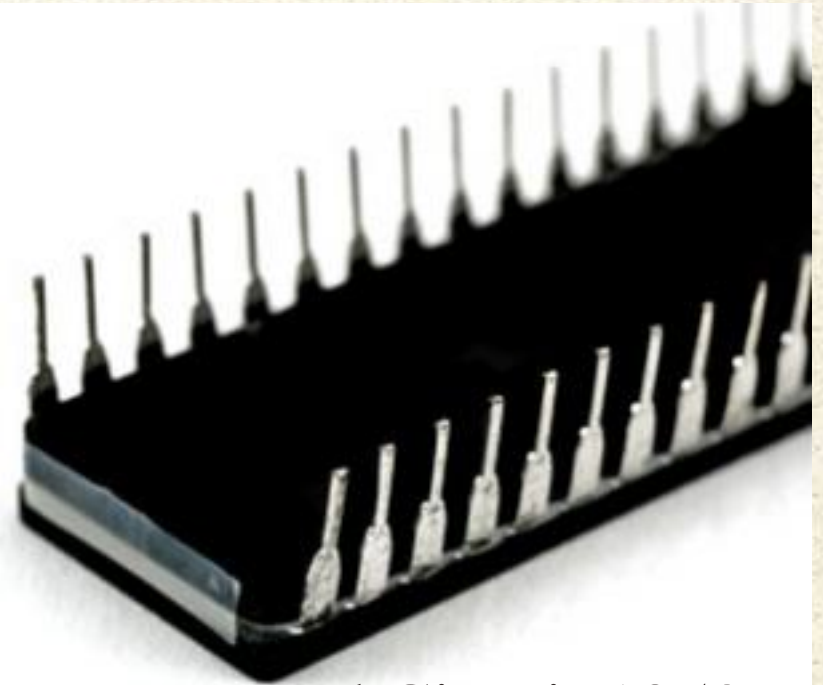Walter Brattain
and William Shockley

Working at Bell Labs
Invented the transistor to replace
vacuum tubes

Integrated Circuits et al

Microcontroller

Integrated Circuit 1950s

Microprocessor 1971

Personal Computers
1970 HP Desktop Computer

IBM PC 1970s

Apple 1977

Laptop (Osborne 1) 1981

Technology Trends

1971 Microprocessor 2,250 transistors
1993 Microprocessor 3,100,000 transistors (3.1 million)
2008 Microprocessor 2,000,000,000 transistors (2 billion)

Today's Microprocessors can do about 10,000,000,000 (10 Billion) calculations per second. That's about the equivalent of every person on the planet doing a math problem each second at the same time. All in one tiny chip.

Specialized graphics processor chips (GPUs) can do more than 1 Trillion calculations per second.

Cost of a 1-Billion calculation/second computer:
1960: $1.1 Trillion, 1984 $15 Million, 1997 $30,000, 2000 $600, 2003 $80, 2007 $0.42, 2009 $0.13

Handheld Computers, Phones, the Cloud

Today's iPhones can do about 5 Million calculations per second.

The iPad and other such devices are replacing desktop and laptop computers.

These devices connect via the internet to large computers that do the heavy calcuations (e.g. Google Docs, photoshop.com)
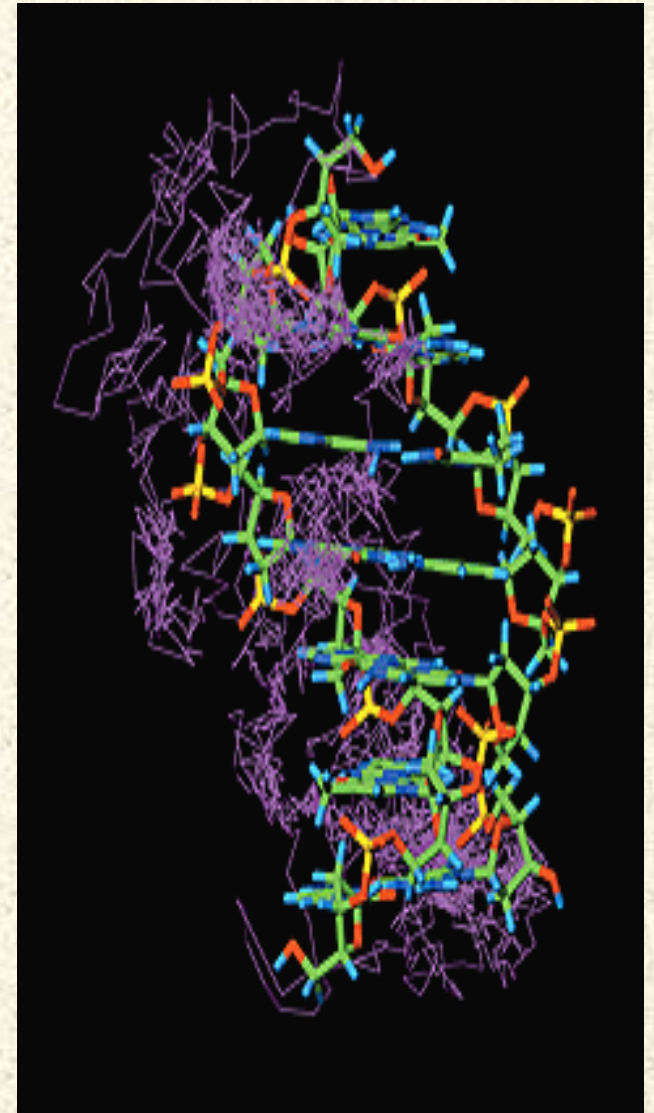
Special-Purpose Computers

- Video Game Consoles
  - Wii, Playstation, Xbox

- Embedded computers
  - Antilock brakes
  - Digital watches
  - MP3 players
  - Sewing machines
  - Greetings Cards
  - GPS
  - Medical devices
  - MRI machines
  - Airplane controls

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Supercomputers

Biggest, most powerful computers for simulations requiring complex calculations

- Climate and weather forecasting
- Automobile and airplane design
- Military weapons simulations
- Motions of galaxies
- Solar energy device research
- Fusion energy development
- Hydrogen fuel cell design
- Motion of pollutants through the ground
- Study of atoms and nuclei, LHC analysis
- Protein simulation; causes of disease
- Energy-efficient engines and combustion

Tips for Online Safety

- Protect Yourself
    - Follow your family's rules
    - Protect your privacy
        - Never email or chat personal info (like passwords)
        - Don't post anything that lets people know where you live, your phone number, etc.
    - Don't respond to strange messages
    - Never, ever, agree to meet someone you met online
- Protect Your Computer
    - Don't open strange e-mail attachments
    - Use anti-virus software
    - Back up your important data (photos, school work)
    - Use a "firewall" on your computer or router

File Formats and Storage

Persistent data is stored on "disks," "tapes," or "flash" memory devices in "files."

Data stored in your computer's volatile memory (or RAM) disappears when the computer is turned off.

- Different kinds of data files have agreed-upon formats.
  - Text: .txt
  - MS Word: .doc
  - Images: .jpg, .gif, .png, .bmp, .tif
  - Sound: .mp3, .aiff, .wav, .aac
  - Video: .avi, .mov, .mpg, .mpeg
- All data is stored as a series of 1s and 0s on the storage media

More about data

- "Plain text" is stored as "ASCII" characters.
  - A number is assigned to each character, e.g. A=65
- Pictures
  - Stored as series of dots, or "pixels", each with 3 numbers for values of RED, GREEN, BLUE (RGB)
  - A monitor's "resolution" tells you how many pixels it can display, e.g. 1024 wide by 768 tall
  - An 1080p HD TV is 1,080 pixels wide
- Sound
  - Sound waves are turned into electrical signals by microphones (or created in the computer!) and then "sampled" and stored.
  - The "sampling frequency" determines how often data is stored. Higher gives better playback reproduction.
- Video
  - Like a series of pictures, but 30 per second (big files!)

Compression

Data compression exploits patterns in data to reduce the storage size, or the size that has to be sent over the internet.

Example baseball linescore:

Giants   100 000 003   4 4 0
Dodgers 000 000 000   0 0 0

Can be shortened to
G 1,7*0,3,4,4,0; D 12*0

Some compression is "lossy," just like sound sampling. Some image formats, like JPG, use something similar to sampling. When you save a JPG, you'll be asked for a "quality" setting.

Software

All computers need to be told what to do!

Ultimately, something needs to tell the computer to change this voltage here this way and there that way, etc.

Software (instructions) tells the computer what to do.

Software developers write "code" in a programming language.

Compilers turn human-readable "code" into instructions computers can understand.

Some "code" is "interpreted" by "run time software" without compiling, e.g. Java

Programming Languages

Programming languages are human-readable files that explain to the computer (via a compiler or runtime system) what to do.

These files, containing "code", can still appear pretty cryptic.

You hear of "good" code and "bad" code. Improper coding results in computer "bugs".

Important languages include
- C and C++ for operating systems and complex applications
- FORTRAN, C, C++ for scientific applications
- Java, PHP, ASP for web applications
- Perl, Python for controlling other applications
- HTML for web pages

Internet and Web

Computers are connected to each other via networks.

The grand network of the world is called the "internet" and the Web refers to all the connections on the internet.

You connect to the internet via "internet service providers", e.g. Comcast high speed cable or wireless 3G cell phone networks. Each device on the internet is identified by a unique number of the form 128.55.38.34. An internet "domain name" maps to one or more of these "IP addresses", e.g. www.google.com -> 74.125.224.52
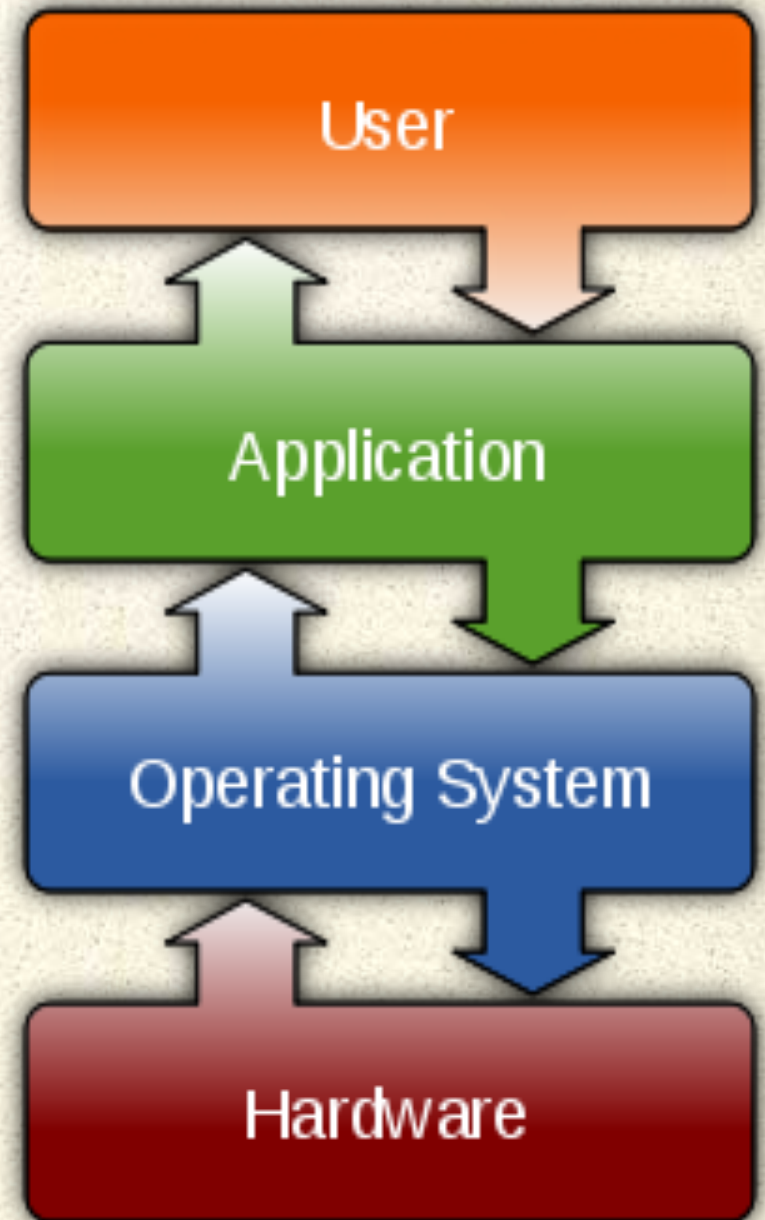
.com = "commercial", .edu = "educational", .gov = "government", .ca = "canada", etc.

Operating System

The operating system keeps the computer alive! It controls interactions with the hardware (CPU, monitor, disks, network) and applications.

Important operating systems

*Windows
*MacOS (OSX)
*Linux
*UNIX
*Android
*iOS

User

Application

Operating System

Hardware

Applications

Software applications are the things you are used to "running" on a computer or handheld device.

- Word (word processor)
- Firefox (web browser)
- Photoshop (image manipulation)
- Angry Birds (game)
- Garage Band (music recorder and editor)
- Excel (spreadsheet)
- PowerPoint (presentations)
- Acrobat (publishing)

Try Google Apps!